

CLAIMS

What is claimed is:

- 1 1. A method for obtaining an assist torque to be applied to a human joint,
2 in a human assist system for applying an assist torque to the human joint, comprising the
3 steps of:
4 determining a gravity compensation control torque value for a first joint;
5 identifying said gravity compensation control torque as being feasible if the
6 relative angular velocity between first and second segment of said first joint is
7 substantially zero; and
8 identifying a gravity compensation control torque feasibility value when said
9 relative angular velocity between said first and second segments of said first joint is not
10 substantially zero, including the steps of:
11 determining a mechanical energy feasibility value of said gravity
12 compensation control torque,
13 determining a metabolic energy feasibility value of said gravity
14 compensation control torque, and
15 calculating said gravity compensation control torque feasibility value
16 based upon said mechanical energy feasibility value and said metabolic energy feasibility
17 value.
- 1 2. The method of claim 1, wherein said mechanical energy feasibility
2 value represents a relationship between a value of an assisted muscle torque and a value
3 of an unassisted muscle torque.

1 3. The method of claim 1, wherein said metabolic energy feasibility value
2 represents a relationship between a value of a metabolic cost of assisted control and a
3 value of a metabolic cost of unassisted control.

1 4. The method of claim 1, further comprising the step of:
2 determining a stability feasibility factor for said gravity compensation control
3 torque.

1 5. The method of claim 4, wherein said step of calculating said gravity
2 compensation feasibility value is based upon said mechanical energy feasibility value,
3 said metabolic energy feasibility value and said stability feasibility factor.

1 6. The method of claim 5, further comprising the step of applying said
2 gravity compensation feasibility factor when said gravity compensation feasibility factor
3 value exceeds a first threshold.

1 7. The method of claim 1, further comprising the step of applying said
2 gravity compensation feasibility factor when said gravity compensation feasibility factor
3 value exceeds a first threshold.

1 8. A method for obtaining an assist torque to be applied to a human joint,
2 in a human assist system for applying an assist torque to the human joint, comprising the
3 steps of:
4 determining a gravity compensation control torque value for a first joint;
5 identifying said gravity compensation control torque as being feasible if the
6 relative angular velocity between first and second segments of the said first joint is
7 substantially zero; and
8 identifying a gravity compensation control torque feasibility value when the
9 relative angular velocity between said first and second segments of the said first joint is
10 not substantially zero, including the steps of:
11 determining a mechanical energy feasibility value of said gravity
12 compensation control torque,
13 determining a stability feasibility factor for said gravity compensation
14 control torque, and
15 calculating said gravity compensation control torque feasibility value
16 based upon said mechanical energy feasibility value and said stability feasibility factor.

1 9. The method of claim 8, wherein said mechanical energy feasibility
2 value represents a relationship between a value of an assisted muscle torque and a value
3 of an unassisted muscle torque.

1 10. A method for obtaining an assist torque to be applied to a human joint,
2 in a human assist system for applying an assist torque to the human joint, comprising the
3 steps of:
4 determining a gravity compensation control torque value for a first joint;
5 identifying said gravity compensation control torque as being feasible if the
6 relative angular velocity between first and second segments of of the said first joint is
7 substantially zero; and
8 identifying a gravity compensation control torque feasibility value when said
9 angular velocity between said first and second segments of the said first joint is not
10 substantially zero, including the steps of:
11 determining a metabolic energy feasibility value of said gravity
12 compensation control torque,
13 determining a stability feasibility factor for said gravity compensation
14 control torque, and
15 calculating said gravity compensation control torque feasibility value
16 based upon said metabolic energy feasibility value and said stability feasibility factor.

1 11. A system for obtaining an assist torque to be applied to a human joint,
2 in a human assist system for applying an assist torque to the human joint, comprising:
3 means for determining a gravity compensation control torque value for a first
4 joint;
5 first identifying means for identifying said gravity compensation control torque
6 as being feasible if the relative angular velocity between first and second segments of
7 said first joint is substantially zero; and

8 second identifying means for identifying a gravity compensation control torque
9 feasibility value when the said angular velocity between said first and second segments
10 of the said first joint is not substantially zero, including:

11 mechanical feasibility means for determining a mechanical energy
12 feasibility value of said gravity compensation control torque,

13 metabolic feasibility means for determining a metabolic energy
14 feasibility value of said gravity compensation control torque, and

15 first calculating means for calculating said gravity compensation
16 control torque feasibility value based upon said mechanical energy feasibility value and
17 said metabolic energy feasibility value.

1 12. The system of claim 11, wherein said mechanical energy feasibility
2 value represents a relationship between a value of an assisted muscle torque and a value
3 of an unassisted muscle torque.

1 13. The system of claim 11, wherein said metabolic energy feasibility value
2 represents a relationship between a value of a metabolic cost of assisted control and a
3 value of a metabolic cost of unassisted control.

1 14. The system of claim 11, further comprising:
2 stability feasibility means for determining a stability feasibility factor for said
3 gravity compensation control torque.

1 15. The system of claim 14, wherein said first compensation means
2 calculates said gravity compensation feasibility value based upon said mechanical energy
3 feasibility value, said metabolic energy feasibility value and said stability feasibility
4 factor.

1 16. The system of claim 15, further comprising application means for
2 applying said gravity compensation feasibility factor when said gravity compensation
3 feasibility factor value exceeds a first threshold.

1 17. The system of claim 11, further comprising application means for
2 applying said gravity compensation feasibility factor when said gravity compensation
3 feasibility factor value exceeds a first threshold.

1 18. A system for obtaining an assist torque to be applied to a human joint,
2 in a human assist system for applying an assist torque to the human joint, comprising:
3 means for determining a gravity compensation control torque value for a first
4 joint;
5 first identifying means for identifying said gravity compensation control torque
6 as being feasible if the angular velocity of between first and second segments of the
7 said first joint is substantially zero; and
8 second identifying means for identifying a gravity compensation control torque
9 feasibility value when said angular velocity between first and second segments of said
10 first joint is not substantially zero, including:
11 mechanical feasibility means for determining a mechanical energy
12 feasibility value of said gravity compensation control torque,
13 stability feasibility means for determining a stability feasibility factor
14 for said gravity compensation control torque, and
15 first calculating means for calculating said gravity compensation
16 control torque feasibility value based upon said mechanical energy feasibility value and
17 said stability feasibility factor.

1 19. The system of claim 18, wherein said mechanical energy feasibility
2 value represents a relationship between a value of an assisted muscle torque and a value
3 of an unassisted muscle torque.

1 20. A system for obtaining an assist torque to be applied to a human joint,
2 in a human assist system for applying an assist torque to the human joint, comprising:
3 means for determining a gravity compensation control torque value for a first
4 joint;
5 first identifying means for identifying said gravity compensation control torque
6 as being feasible if the said relative angular velocity between the first and second
7 segments connecting the said first joint is substantially zero; and
8 second identifying means for identifying a gravity compensation control torque
9 feasibility value when the said relative angular velocity between said first and second
10 segments connecting the said first joint is not substantially zero, including:
11 metabolic feasibility means for determining a metabolic energy
12 feasibility value of said gravity compensation control torque,
13 stability feasibility means for determining a stability feasibility factor
14 for said gravity compensation control torque, and
15 first calculating means for calculating said gravity compensation
16 control torque feasibility value based upon said metabolic energy feasibility
17 value and said stability feasibility factor.